

Executive Summary

ES.1 Introduction

The Air Toxics “Hot Spots” Information and Assessment Act (AB 2588, Connelly, stat. 1987; Health and Safety Code Section 44300 et seq.) is designed to provide information on the extent of airborne emissions from stationary sources and the potential public health impacts of those emissions. Facilities provide emissions inventories of chemicals specifically listed under the “Hot Spots” Act to the local Air Pollution Control and Air Quality Management Districts and ultimately to the state Air Resources Board. Following prioritization of facilities by the Districts based on quantity and toxicity of emissions, facilities may be required to conduct a health risk assessment. Health risk assessment involves a comprehensive analysis of the dispersion of emitted chemicals in the air and the extent of human exposure via all relevant pathways (exposure assessment), the toxicology of those chemicals (dose-response assessment), and the estimation of cancer risk and noncancer health impacts to the exposed community (risk characterization). The statute specifically requires OEHHA to develop a “likelihood of risks” approach to health risk assessment; OEHHA has, therefore, developed a stochastic, or probabilistic, approach to exposure assessment to fulfill this requirement.

The Air Toxics Hot Spots Program Part IV: Technical Support Document, Exposure Assessment and Stochastic Analysis (Part IV) provides a review of the scientific literature on the exposure variates needed in order to perform risk assessment for the Air Toxics Hot Spots program. The airborne toxicants addressed are listed in the statute and include Toxic Air Contaminants. Most of the chemicals listed are volatile and thus only present a significant risk when emitted into the air if inhaled. However, a few chemicals that are listed, such as heavy metals and semivolatile organic compounds, can also be deposited onto vegetation, water and soil. Thus, Part IV also addresses other potential exposure pathways including ingestion of contaminated soil, home grown produce, meats, cow’s milk, mothers milk, noncommercial fish, surface drinking water and skin contact with soil. Specific recommendations are made for the most appropriate parameters and distributions. The stochastic approach described in this document provides guidance to the facility operators who want to conduct a stochastic risk assessment, and facilitates use of supplemental information to be considered in the health risk assessment. In addition, this document updates the point estimate approach currently used in the Air Toxics Hot Spots program.

A companion document, Air Toxics “Hot Spots” Risk Assessment Guidance Manual, is under development and is designed to be concise compendium of the algorithms, parameters and tables of health values (cancer potency factors, acute and chronic reference exposure levels) needed to perform an AB-2588 risk assessment.

ES.2 OEHHA's Approach to Exposure Assessment

The traditional approach to exposure and risk assessment has been to assign a single value for each exposure parameter, such as breathing rate, generally chosen as a high-end value so that risk will not be underestimated. The "high-end" value has not in the past been well defined such that it is unclear where the value fell on a distribution. An improvement over the single point estimate approach is to select two values, one representing an average and another representing a defined high-end value. OEHHA provides information in this document on average and defined high-end values for key exposure variates. The average and "high-end" values of point estimates in this document are defined in terms of the probability distribution of values for that variate. We chose the means to represent average values for point estimates and the 95th percentiles to represent high-end values for point estimates from the distributions identified in this document. Thus, within the limitations of the data, average and high end are well-defined points on the distribution

OEHHA was directed under SB-1731 to develop a "likelihood of risk" approach to risk assessment. To satisfy this requirement, we developed a stochastic approach to risk assessment which utilizes distributions for exposure variates such as breathing rate and water consumption rate rather than a single point estimate. The variability in exposure can be propagated through the risk assessment model using the distributions as input and a Monte Carlo or similar method. The result of such an analysis is a range of risks that at least partially characterizes variability in exposure. Such information allows the risk manager an estimate of the percentage of the population at various risk levels.

We also recommend a tiered approach to risk assessment. Tier 1 is a standard point estimate approach using the recommended point estimates presented in this document. If site-specific information is available to modify some point estimates and is more appropriate to use than the recommended point estimates in this document, then Tier 2 allows use of that site-specific information. In Tier 3, a stochastic approach to exposure assessment is taken using the distributions presented in this document. Tier 4 is also a stochastic approach but allows for utilization of site-specific distributions if they are justifiable and more appropriate for the site under evaluation than those recommended in this document.

ES.2.1 Stochastic Exposure Assessment

Distributions of key exposure variates were taken from the literature, if adequate, or developed from raw data of original studies. Intake variates such as vegetable consumption are relatively data rich for which reasonable probability distributions can be constructed. However, the data necessary to characterize the variability in risk assessment variates are not always available. For example, for the fate and transport parameters (i.e., fish bioconcentration factors), there are only a few measurements available which precludes the adequate characterization of a probability distribution. We only developed distributions for those key exposure variates that were adequately characterized by data.

Note that the stochastic approach employed in the Air Toxics “Hot Spots” program does not address either exposure model uncertainty or true uncertainty about an exposure variate. In addition, this document does not characterize uncertainty in dose-response modeling. Although stochastic methods like the one described in this document are frequently referred to in the risk assessment literature as “uncertainty” analyses, in reality, they may deal only with the measured variability in those variates treated stochastically, and not with true uncertainty. The results of the stochastic risk assessment using the information in this document are intended to quantify a good portion of the variability in human exposure in the population.

OEHHA attempted to use studies representative of the population of California in so far as possible. OEHHA identified the best distribution in the literature for water consumption rates. We developed a distribution for fisher caught non-commercial fish consumption from raw data from a study done in Santa Monica Bay in California. We developed a breathing rate distribution from the data of two activity studies and a breathing rate study sponsored by the California Air Resources Board. We developed a distribution of breast milk consumption rates for infants by combining raw data from two different studies. We developed distributions of the consumption rates of chicken, beef, pork, dairy products, leafy, exposed, protected, and root vegetables from information in the USDA Continuing Survey of Food Intake. Where data permitted we developed children’s consumption distributions separately. Our distributions are expressed as intake per unit body weight utilizing in all but one case the body weights of the subjects reported in the original studies. As more data become available, OEHHA will periodically update Part IV.

ES.2.2 Point Estimate Approach to Exposure Assessment

OEHHA updated the parameters used in the point estimate approach. We refined our approach by using an estimate of average and high-end consumption rates, defined as the mean and 95th percentiles of the distribution, respectively, rather than a single point estimate. In this document, we introduce evaluation of 9, 30 and 70 year exposure durations instead of just a single 70-year exposure duration. The parameters used for the 9-year exposure scenario are for the first 9 years of life and are thus protective of children. Children have higher intake rates on a per kg body weight basis and thus receive a higher dose from contaminated media.

ES.3 Contents of This Document

ES.3.1 Air Dispersion Modeling

The concentration of pollutants in the ambient air is a key determinant of risk and is needed to conduct a risk assessment. Chapter 2 provides a description of available air dispersion models useful for the risk assessment of airborne contaminants emitted by

stationary sources. Appropriate models are all USEPA approved. A description of appropriate air dispersion modeling report preparation is provided in Section 2.15.

ES.3.2 Breathing Rate

Chapter 3 provides information we used to develop breathing rate distributions. To characterize distribution of breathing rates in L/kg-day, we evaluated data from Adams (1993) on ventilation rates in a cross-section of the population measured while performing specific tasks. Mean breathing rates for specific tasks in the Adams study were then assigned to similar tasks recorded in two large activity patterns surveys (Wiley et al., 1991 a and b; Jenkins et al. 1992; see References Section 3.7). Daily breathing rates were then calculated for each individual in the activity patterns surveys by summing minutes at a specific activity times the ventilation rate for that activity across all activities over a 24 hour period. These breathing rates were then used to develop a distribution of breathing rates for children and for adults. A simulated breathing rate distribution for a lifetime (from age 0 to 70 years) was derived from the children and adult distributions. Recommendations for point estimates and distributions of breathing rate useful for chronic exposure assessment are provided in Section 3.6.

ES.3.3 Soil Ingestion Rates

Airborne chemicals may deposit onto soil and pose a risk through incidental or intentional ingestion of contaminated surface soil. Chapter 4 focuses on the soil ingestion pathway of exposure, and in particular on the default point estimates of soil ingestion rates. This pathway is not a major contributor to the risk for most chemicals in the Air Toxics "Hot Spots" program. However, there are some compounds (e.g., polychlorinated dibenzo-p-dioxins and furans, polycyclic aromatic hydrocarbons, some metals) for which soil ingestion may contribute a significant portion of the total dose and cancer risk estimate. It is not possible given the existing studies to develop reliable soil ingestion rate distributions appropriate to use for site-specific risk assessments. At this time, OEHHHA is not recommending a distribution for use in the Air Toxics "Hot Spots" program pending resolution of the various problems associated with estimating soil ingestion rates and characterizing an appropriate distribution. Recommendations of point estimates useful in a risk assessment involving potential exposure via soil ingestion can be found in Section 4.7.

ES.3.4 Breast milk consumption

Chapter 5 describes information on breast milk consumption and the development of a distribution for breast milk consumption rates. Breast milk consumption is an indirect but important exposure pathway for some environmental contaminants. For example, some airborne toxicants (e.g., semi-volatile organic chemicals) deposited in the environment bio-magnify and become concentrated in human adipose tissue and breast milk lipid. Highly lipophilic, poorly metabolized chemicals such as TCDD, DDT and PCBs are sequestered in adipose tissue and only very slowly eliminated except during lactation. These toxicants in breast milk lipid appear to be in equilibrium with adipose tissue levels, and over time the breast-fed infant may receive a significant portion of the

total maternal load. OEHHA developed distributions of breast milk intake rates from data published in two studies (Dewey et al., 1991; Hofvander et al., 1982; see References Section 5.7). Recommendations for point estimate values and distributions for use in exposure assessment where breast milk is a potential exposure pathway are presented in Section 5.6.

ES.3.5 Dermal Exposure

Uptake of chemicals through the skin could be significant for some of the Hot Spots-listed contaminants. However, it should be noted that dermal absorption of chemicals that are originally airborne is a relatively minor pathway of exposure compared to inhalation and ingestion exposure pathways. Uptake of chemicals which have settled onto surfaces as particles onto a surface (leaves, soil, furniture, etc.) is the important relevant pathway for initially airborne substances. This route applies to semivolatile organic chemicals like dioxins and PCBs, and some metals like lead. Competition between evaporation from the skin and dermal absorption results in a distribution of the chemicals between air, dust particle, and skin phases which depends on volatility, relative solubilities in the phases, temperature, and other factors. We are recommending a simple point estimate approach to assessing dermal exposure. Values of expose surface area, soil loading, and exposure frequency useful for assessing dermal exposure are provided in Section 6.5. In addition, dermal absorption factors are provided for specific chemicals in Appendix F.

ES.3.6 Food Intake Rates

Some of the toxic substances emitted by California facilities such as semivolatile organics and metals can be deposited as particles onto soil, surface water and food crops. Home raised chickens, cows and pigs may be exposed through consumption of contaminated feed, pasture, soil, water and breathing of contaminated air. Persons consuming garden produce or home-raised animal products may be exposed to toxic substances that were initially airborne but made their way into the food chain. Probability distributions and default consumption rates for homegrown vegetables and fruits, chicken, beef, pork, cow's milk and eggs are discussed in Chapter 7. Homegrown rather than commercially produced produce, meat and milk are evaluated in the AB-2588 program because risk to the population adjacent to a facility is influenced more by home-grown or raised foods than commercially-bought foods. While a facility could contaminate commercially grown produce, meat and milk, typically commercially grown products come from diverse sources. Thus the risk to an individual from consuming commercial products contaminated from a single facility is likely to be quite small.

OEHHA has used the U.S. Department of Agriculture's Continuing Survey of Food Intakes of Individuals (CSFII) 1989-91 survey data for the Pacific region to generate per capita consumption distributions for produce, meat (beef, chicken, and pork), dairy products and eggs. Produce was categorized into exposed, leafy, protected, and root for the purposes of determining concentrations in the produce. The availability of body weight data for each subject in the survey enabled consumption rates to be expressed in gram/kg

body weight/day. Recommendations for point estimates and distributions are found in Section 7.9.

ES.3.7 Water Intake Rates

Deposition of airborne contaminants can result in exposure through drinking water. Airborne substances can deposit directly on surface water bodies used for drinking water and other domestic activities. (Material carried in by surface run-off is not considered at this time.) Chapter 8 assesses available information on individual water consumption rates and distributions for use in stochastic types of exposure assessment. OEHHHA adopted distributions published in the literature (Ershow and Cantor, 1989; Ershow et al., 1991; see References Section 8.5) of water intake rates based on data from the USDA 1977-78 Nationwide Food Consumption Survey. We simulated a distribution for 0-9 year exposures using information in the literature. Recommendations for point estimates and distributions are provided in Section 8.4.

ES.3.8 Fish Consumption Rates

The “Hot Spots” (AB-2588) risk assessment process addresses contamination of bodies of water, mostly fresh water, near facilities emitting air pollutants. Chapter 9 describes available information on fish consumption rates and describes the development of a distribution from the Santa Monica Bay Seafood Consumption Study (1994; see References Section 9.7). The consumption of fish from contaminated bodies of water can be a significant exposure pathway, particularly for lipophilic toxicants such as dioxins. Commercial store-bought fish generally come from a number of sources. Thus, except in the rare event that fish in these bodies of water are commercially caught and eaten by the local population, the health risks of concern are due to noncommercial fishing. Therefore, the noncommercial fish consumption rate is a critical variate in the assessment of potential health risks to individuals consuming fish from waters impacted by facility emissions. Recommendations of values for point estimates and distributions of fish consumption rates are provided in section 9.5.

ES.3.9 Body Weight

Body weight (BW) is an important variate in risk assessment that is used in calculating dose (mg/kg BW/day). Many of the studies that OEHHHA used to generate the distributions and point estimates collected body weight data on the subjects in the study. The consumption rate for each subject was divided by the body weight of that subject, and distributions of consumption per unit body weight per day were generated. However, the study used to determine fish consumption rate, did not collect body weight information on the subjects. Chapter 10 provides a review of the body weight literature. The published literature on body weight is mainly based on data gathered in the first National Health and Nutrition Examination Survey conducted between 1970 and 1974, and more recently in the second National Health and Nutrition Examination Survey (NHANES II). Appropriate body weight defaults were selected for our purposes. Recommendations are provided in Section 10.4.

ES.3.10 Duration of Exposure

Currently an assumption of lifetime exposure duration (70 years) for the calculation of cancer risk is incorporated into the cancer unit risk factor and oral cancer potency factors. Thus, when risk is calculated by multiplying modeled or measured concentrations in air by the unit risk factor, the risk is generally considered a “lifetime” risk. A cancer risk of 5×10^{-5} means that in a population exposed for 70 years, 50 people per million exposed would theoretically develop cancer over that 70 year period.

The point estimate risk assessment approach (Tier 1 and 2) can be used with more than one estimate of exposure duration to give multiple point estimates of cancer risk resulting from various chronic exposure durations. For stochastic risk assessment (Tier 3 and 4), the assessor could calculate separate cancer risk distributions for each fixed duration of exposure. In Chapter 11, OEHHA presents information for point estimates of exposure duration of 9, 30, and 70 years. Recommendations are provided in Section 11.5.